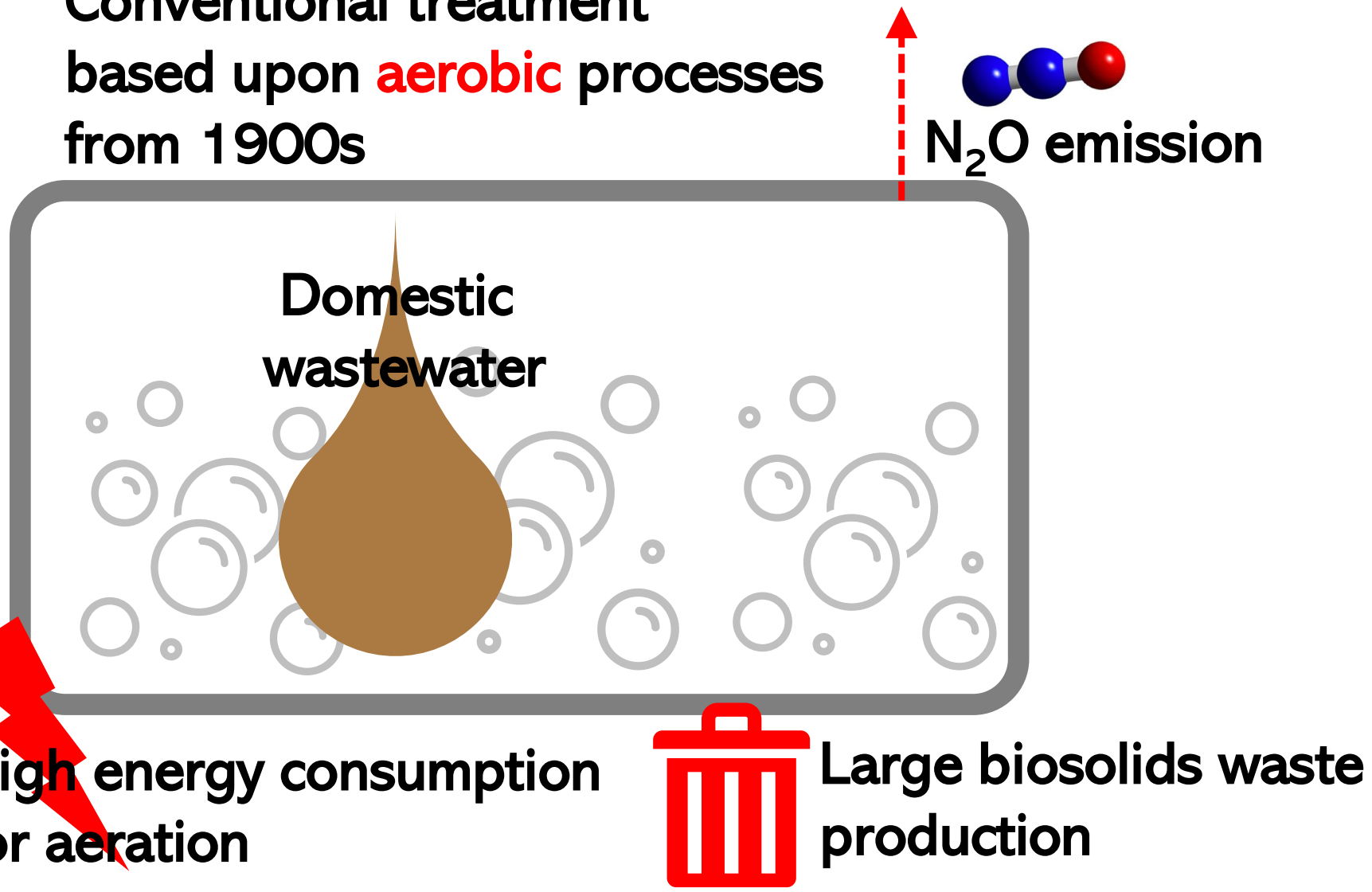
California-United Water Conference
Silicon Valley Tour

SAF-MBR: net energy-producing anaerobic secondary treatment

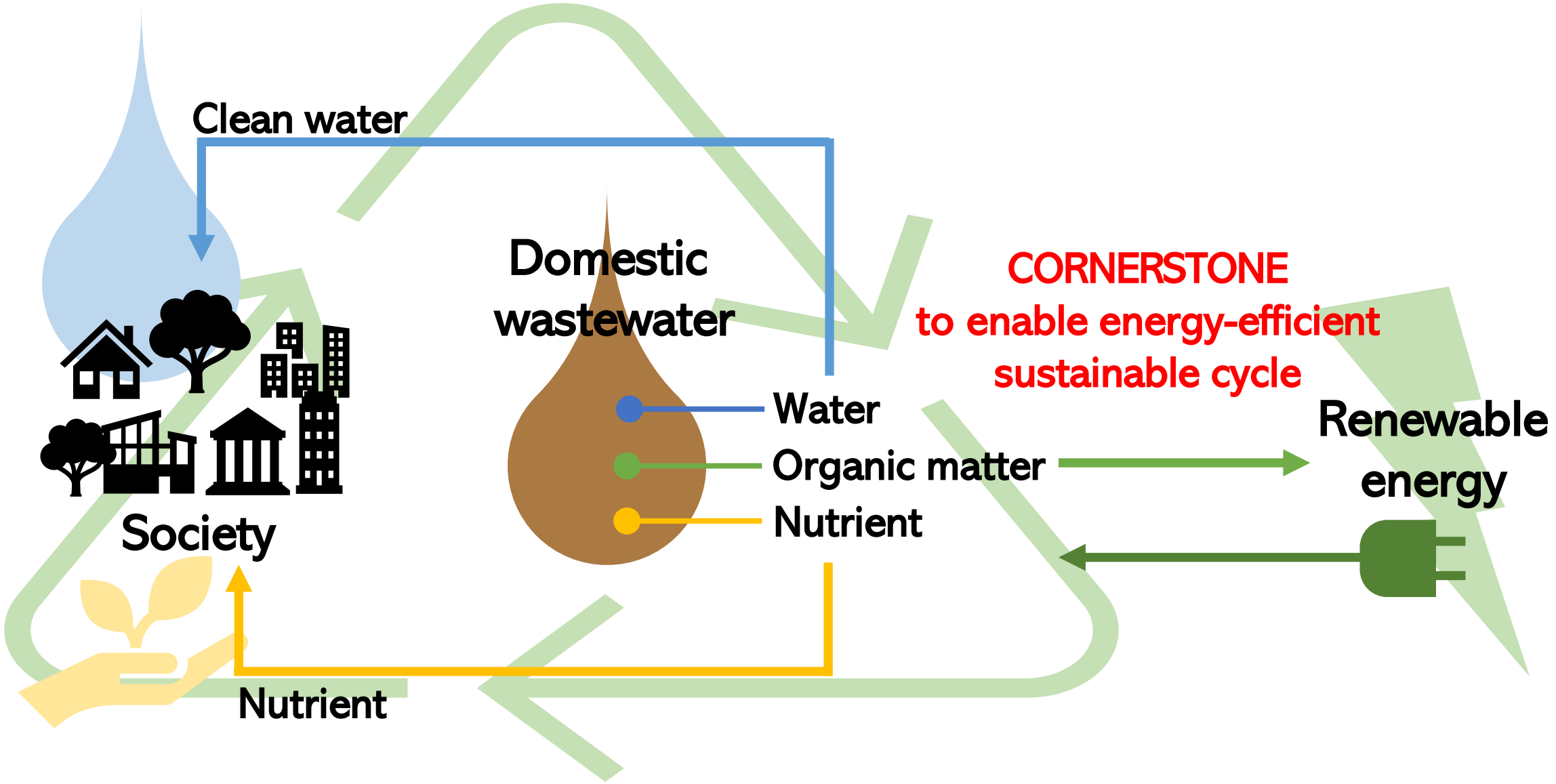
Chungheon Shin
Stanford University

Conventional secondary treatment

Conventional treatment
based upon aerobic processes
from 1900s



Resources in domestic wastewater



Professor Perry McCarty and his big dream

Environmental Science & Technology

FEATURE

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Domestic Wastewater Treatment as a Net Energy Producer—Can This be Achieved?

Perry L. McCarty,*[,†,‡] Jaeho Bae,[‡] and Jeonghwan Kim[‡]

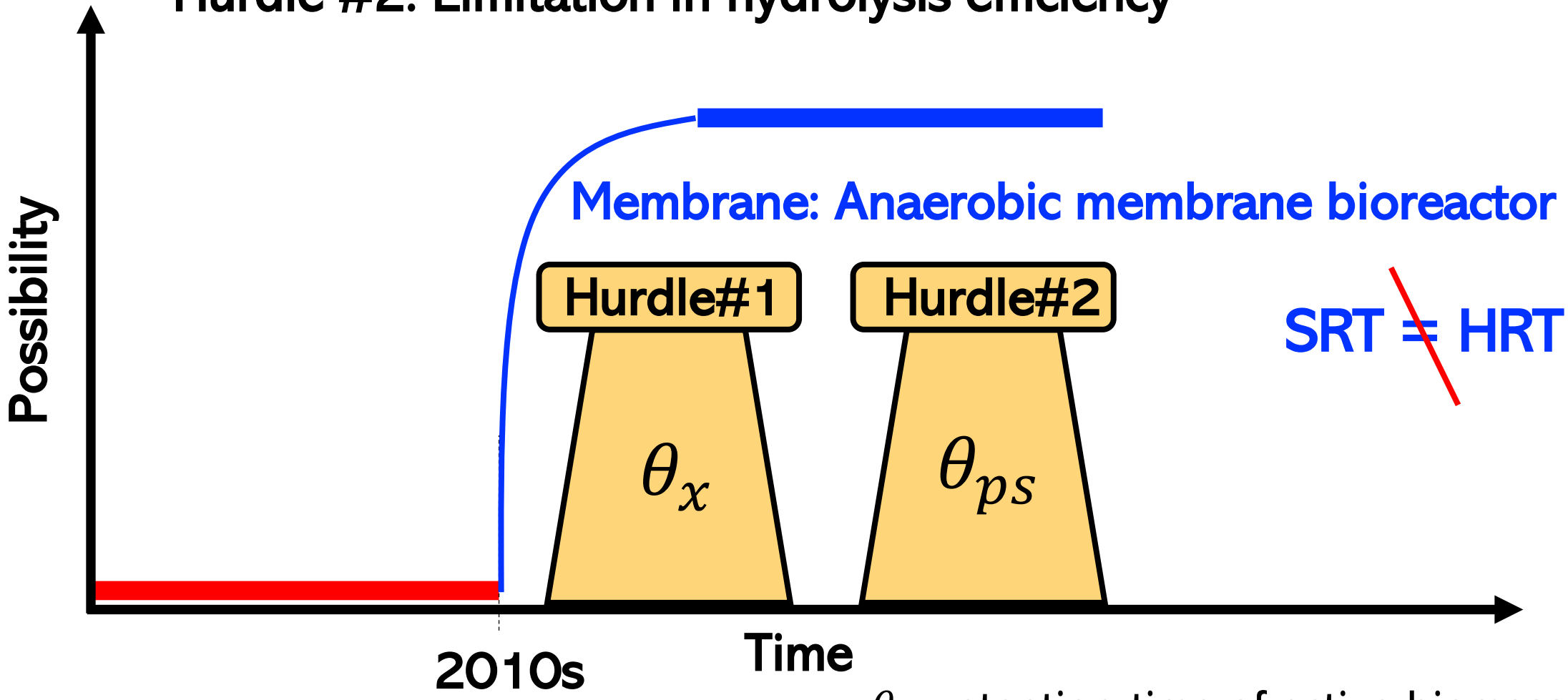
Anaerobic secondary treatment

- Not requiring energy-intensive aeration
- Producing methane as a renewable energy source
- Having significantly less biosolids production

Anaerobic secondary treatment

Hurdle #1: Slow growth rate of anaerobic microorganism

Hurdle #2: Limitation in hydrolysis efficiency

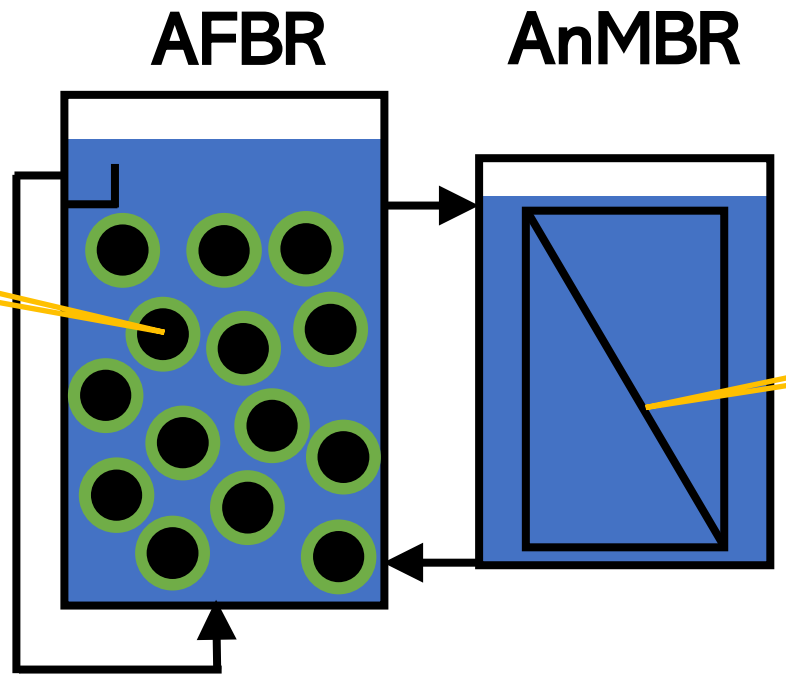


θ_x: retention time of active biomass

θ_{ps}: retention time of particulate substrate

SAF-MBR

Staged Anaerobic Fluidized Membrane Bioreactor



GAC biocarrier

Enabling
> 500 days SRT
for microorganism

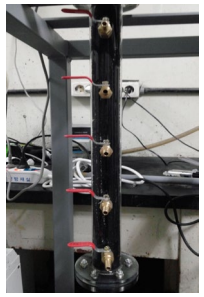
Membrane

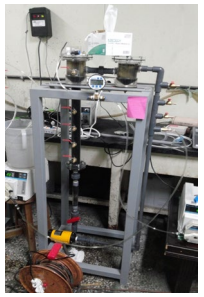
Enabling sufficient hydrolysis
while producing
particle-free effluent

Three retention times

1. HRT
2. SRT of MLSS
3. SRT of microorganisms

SAF-MBR development





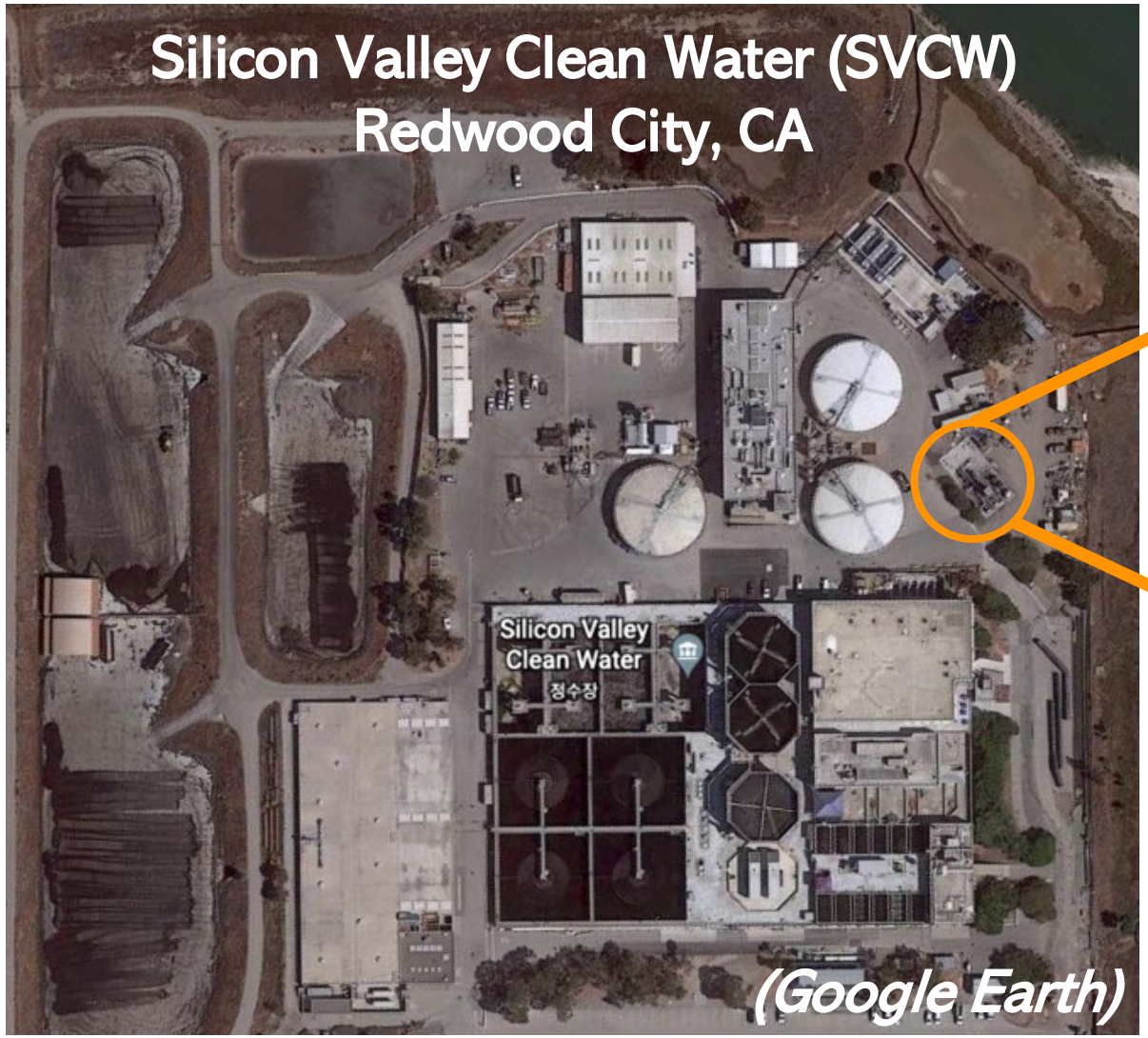
Lab-scale studies
(1~2 gal/d)


Pilot-scale studies
(< 6,000 gal/d)

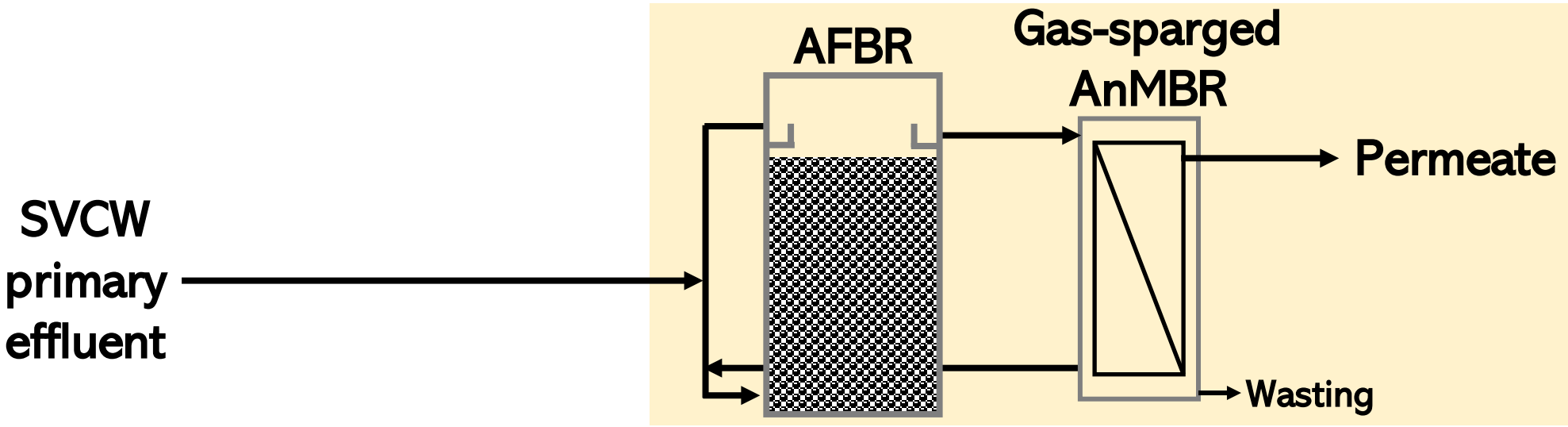
Demonstration
-scale
SAF-MBR
(24,000 gal/d)

2009 2013 2020 2021

The demonstration-scale SAF-MBR system at SVCW



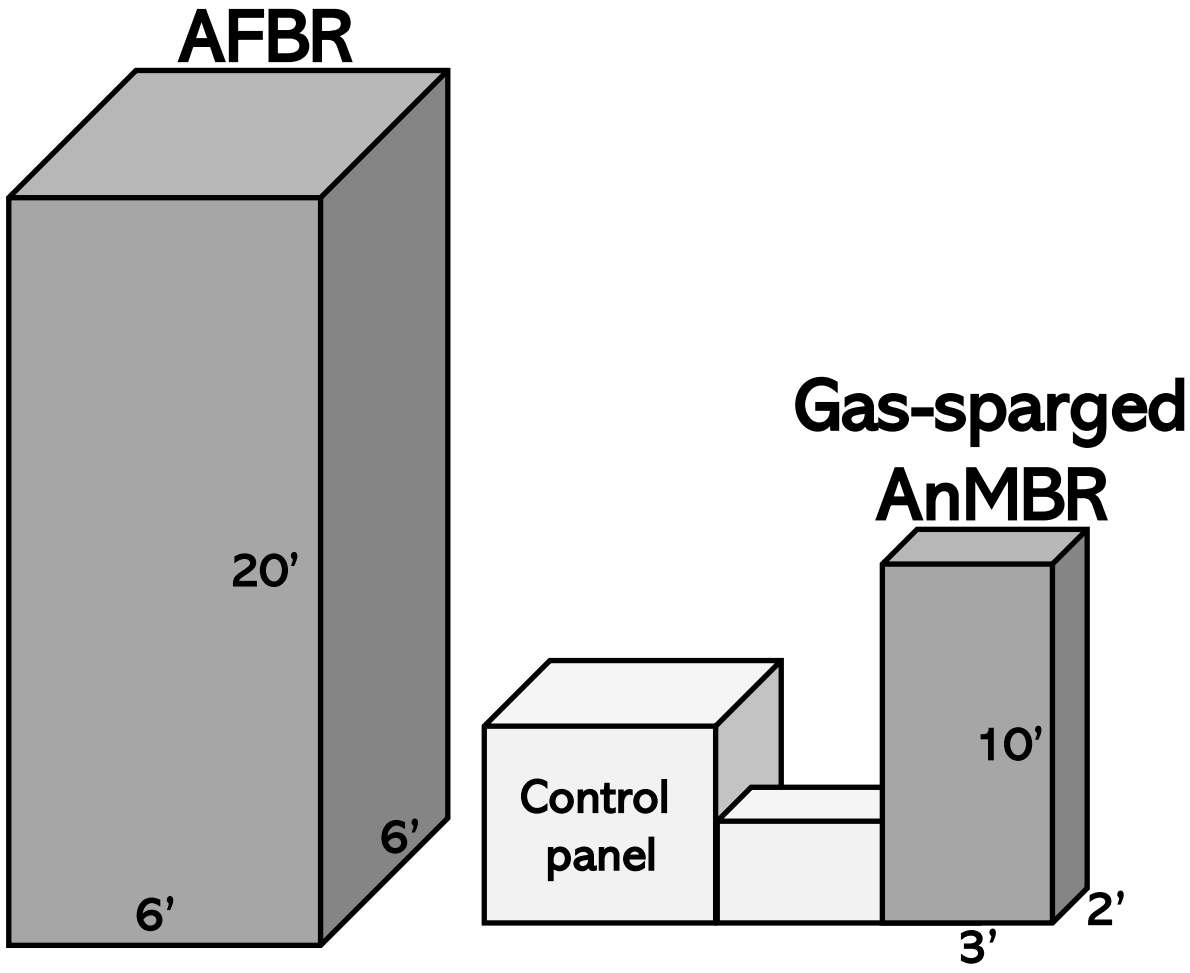
The demonstration-scale SAF-MBR system at SVCW



Current operating condition

- 5 h HRT
- 22 d SRT
- 12 L/m^2/h net membrane flux
- No temperature control

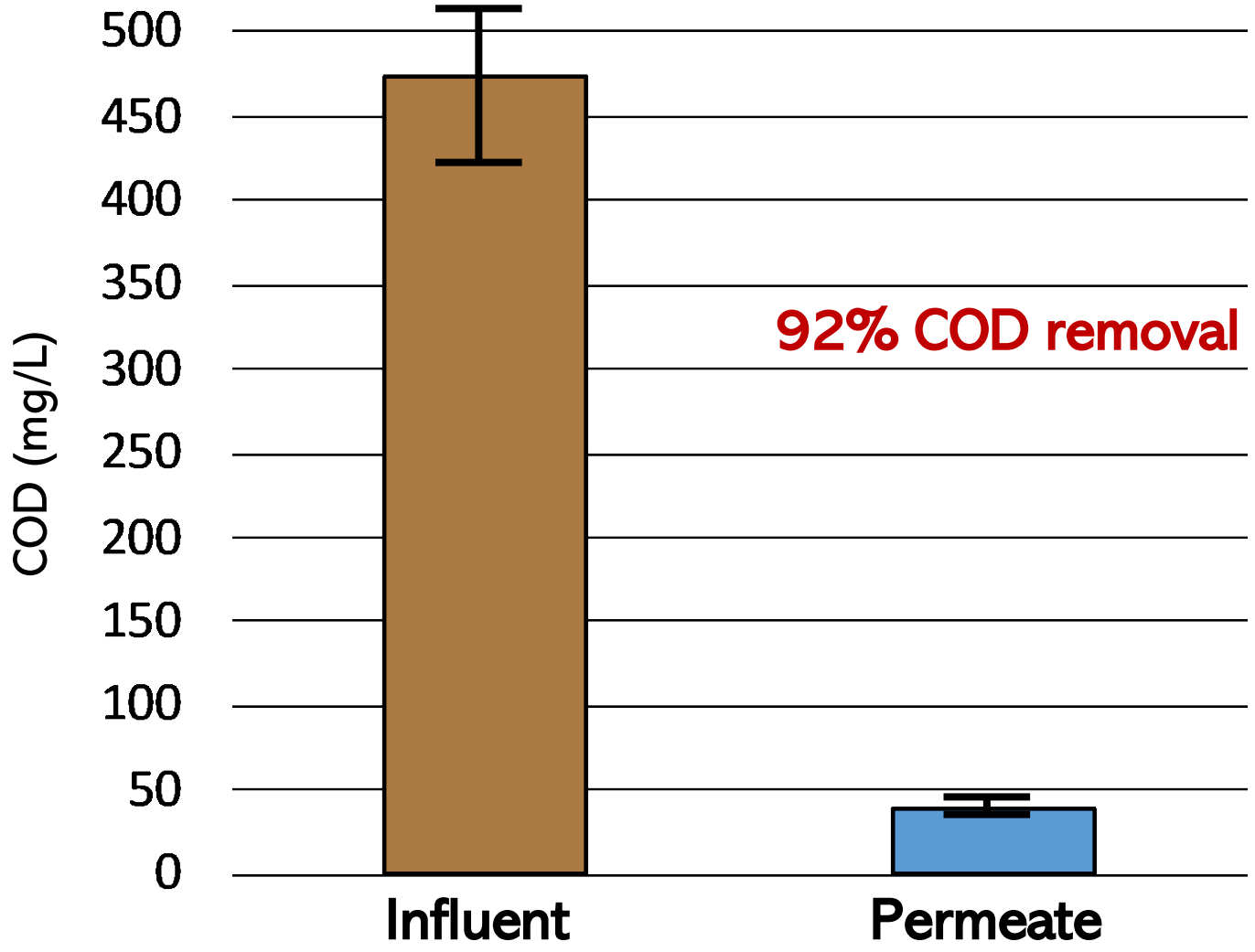
The demonstration-scale SAF-MBR system at SVCW



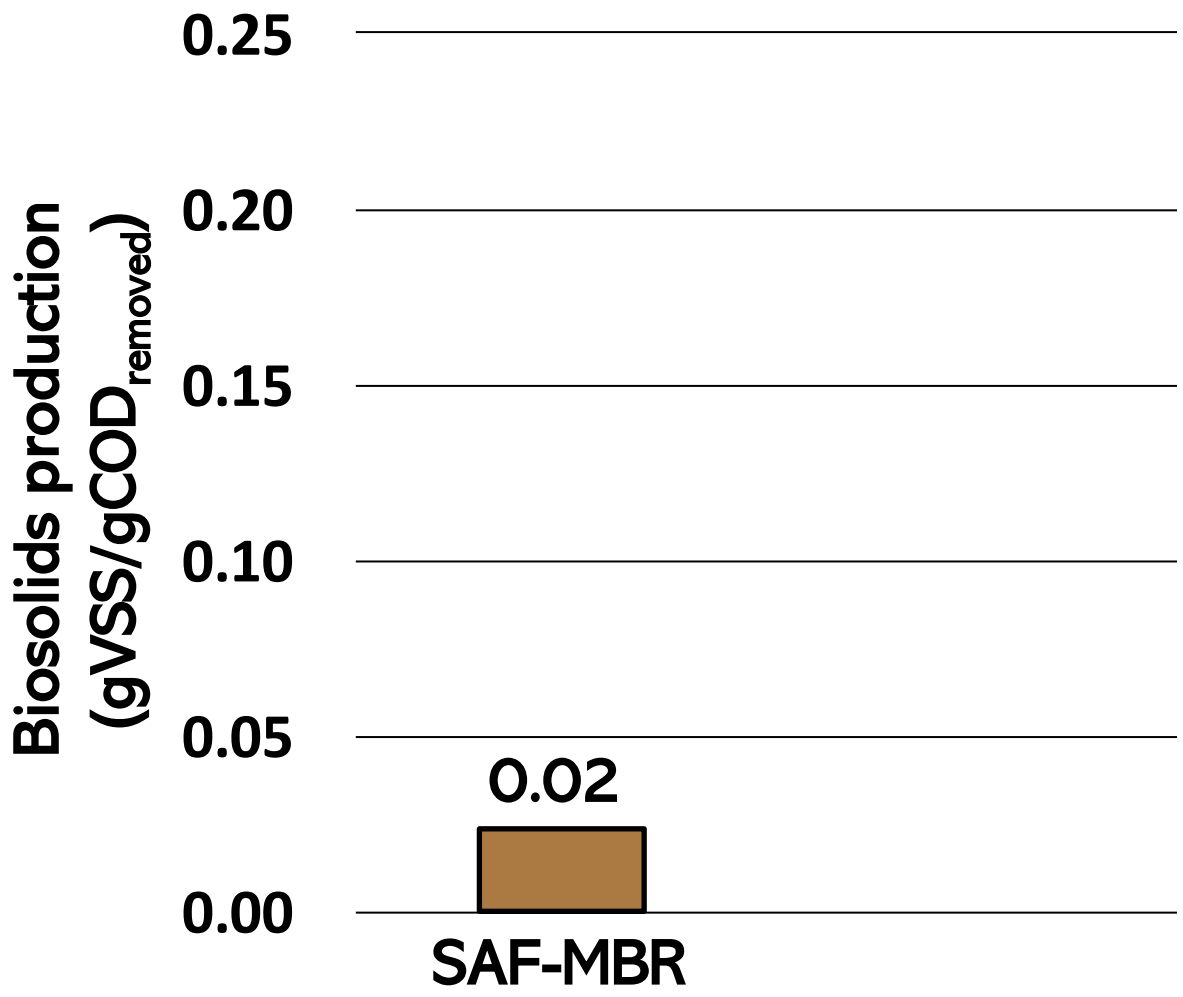
VEOLIA

9 ZeeWeed 500D UF membrane modules
LEAPmbr diffuser

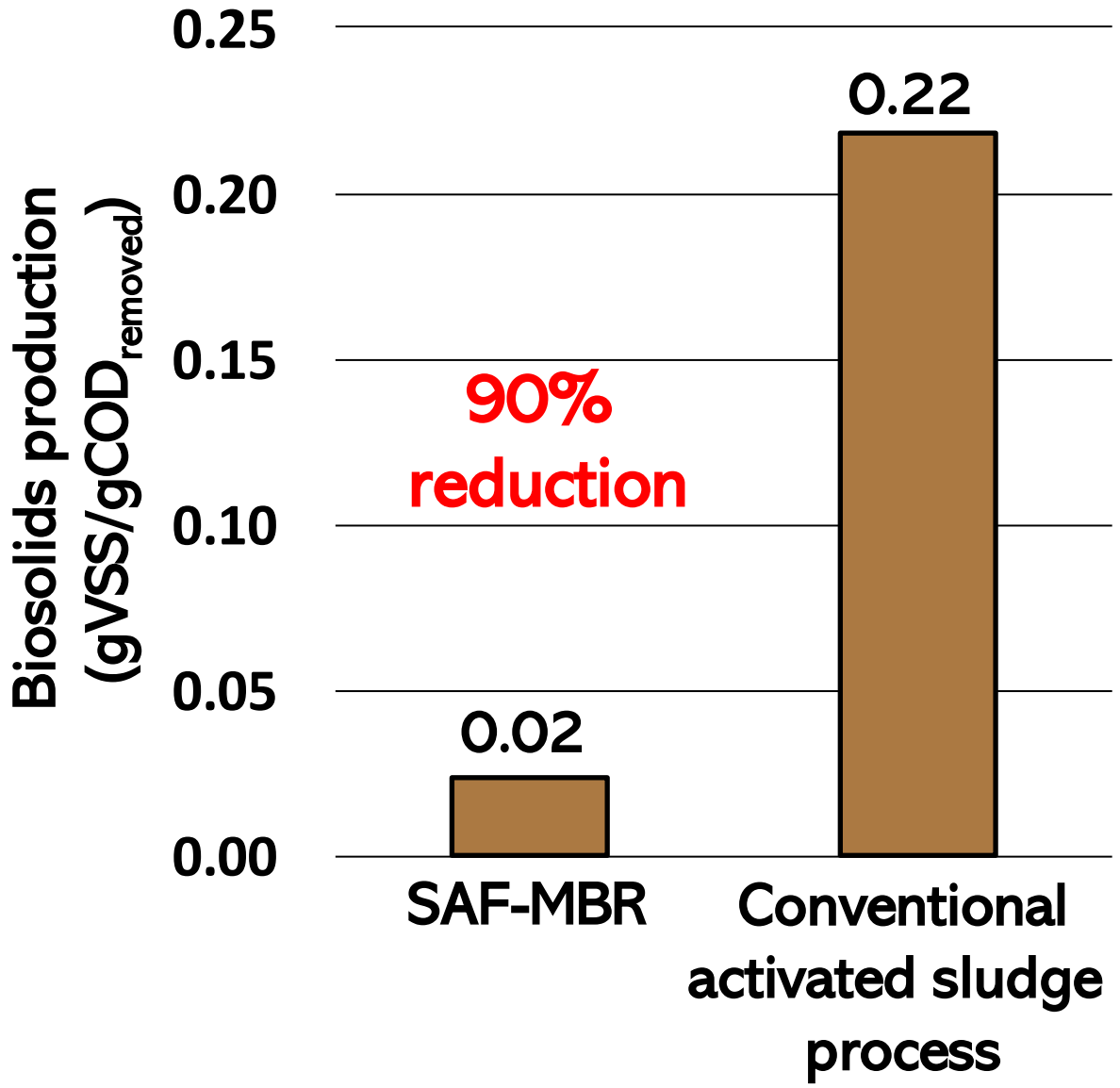
Performance: COD removal



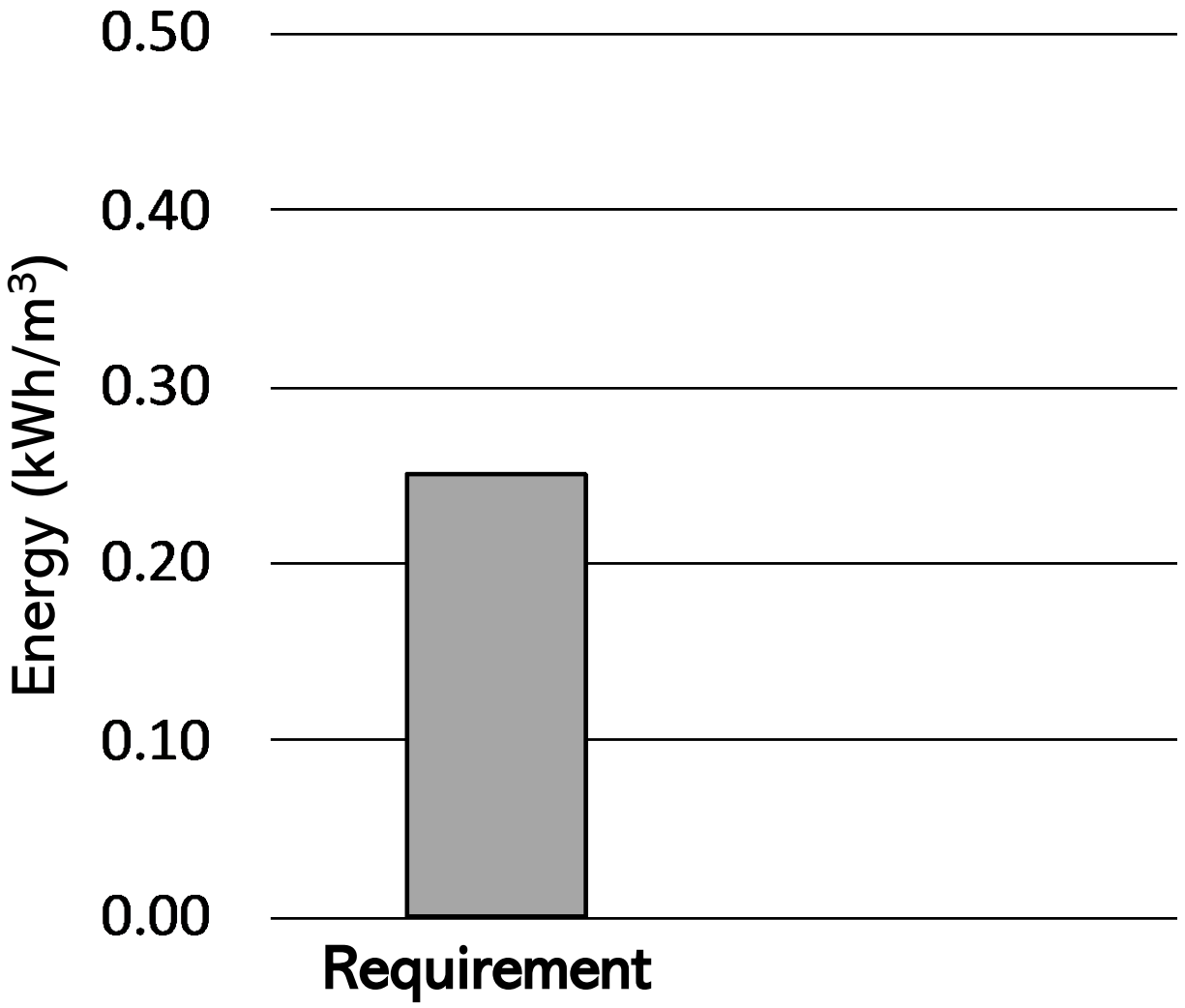
Performance: secondary sludge production



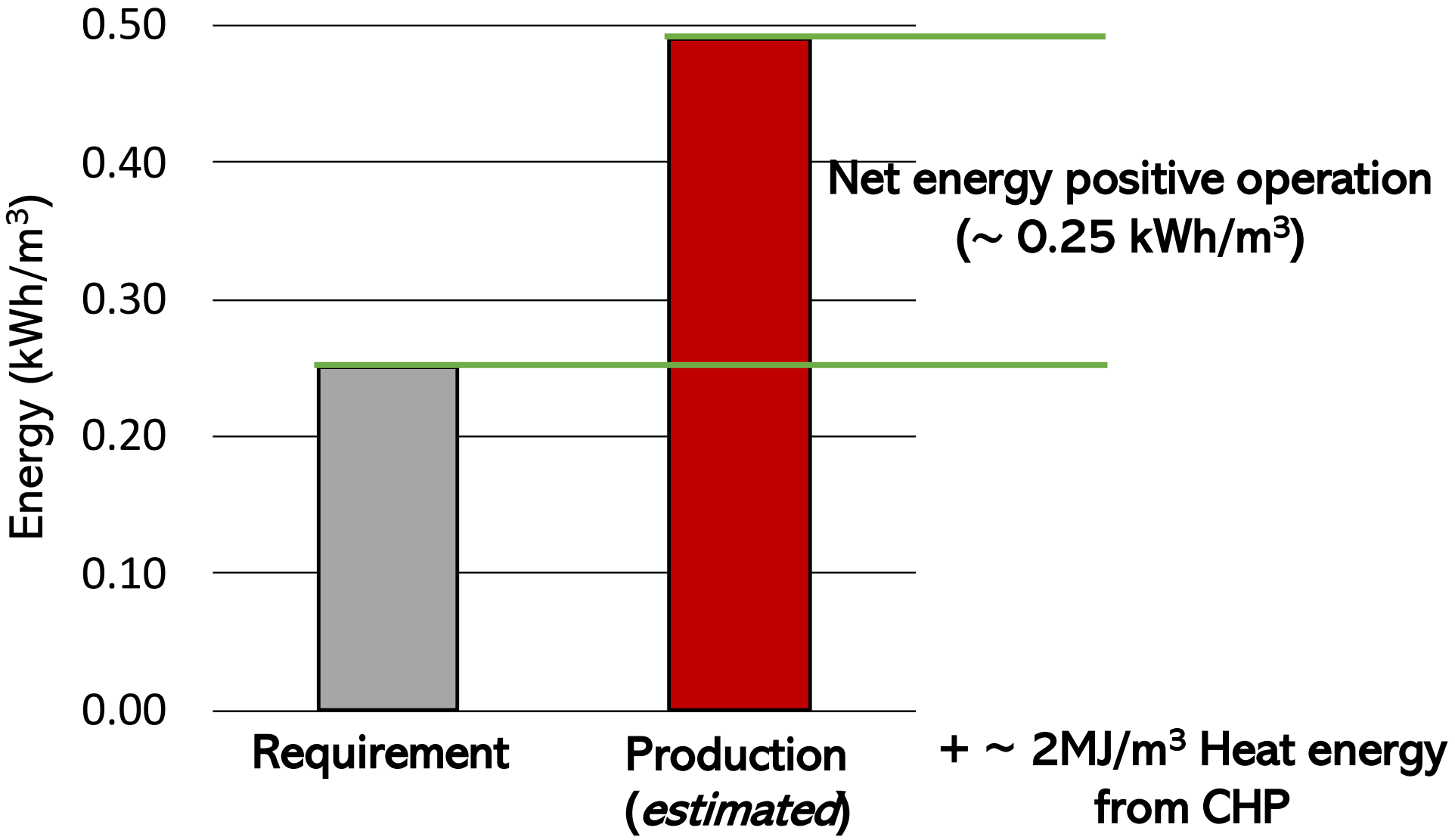
Performance: secondary sludge production



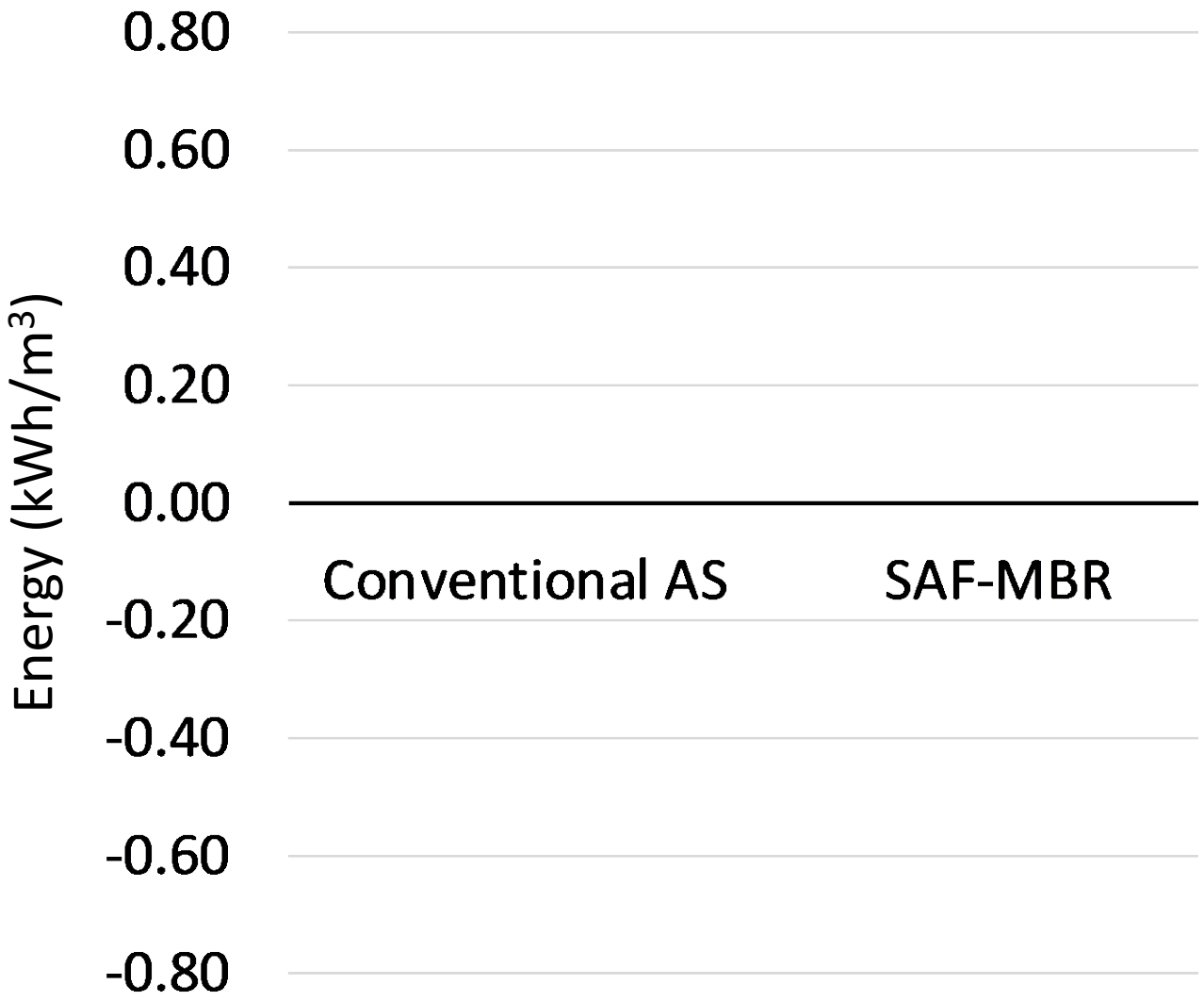
Performance: electrical energy balance



Performance: electrical energy balance



Performance: energy balance



Performance: energy balance

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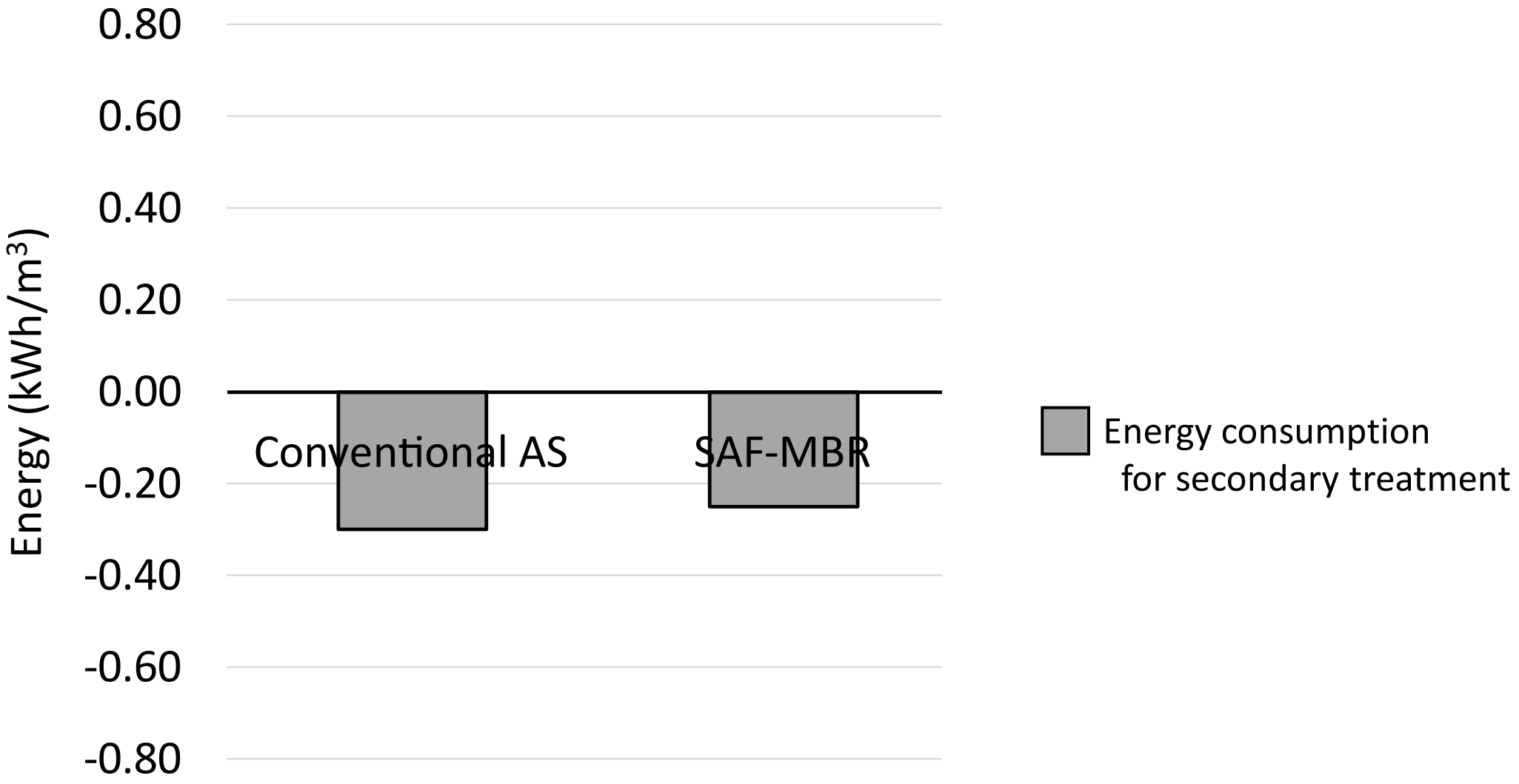

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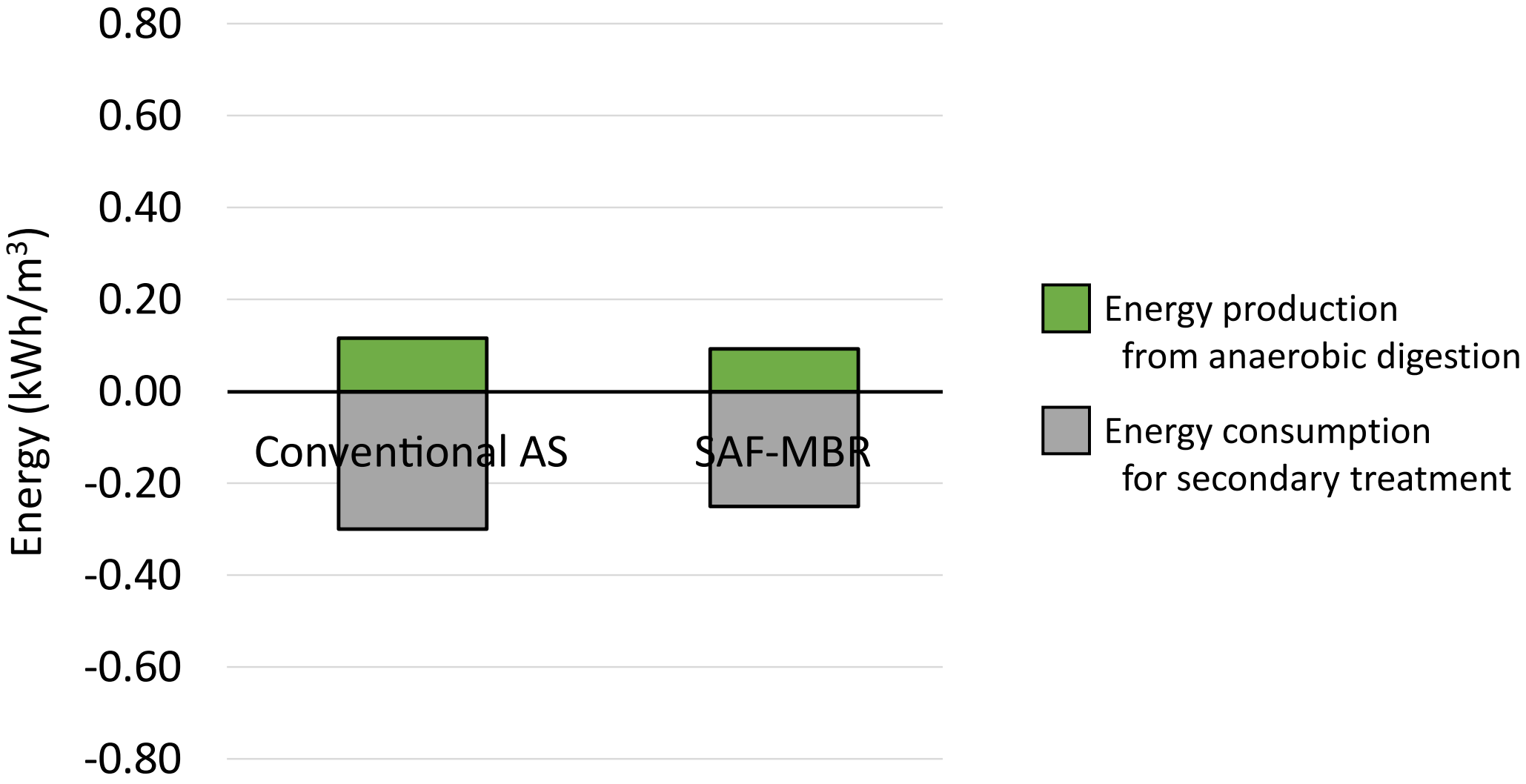
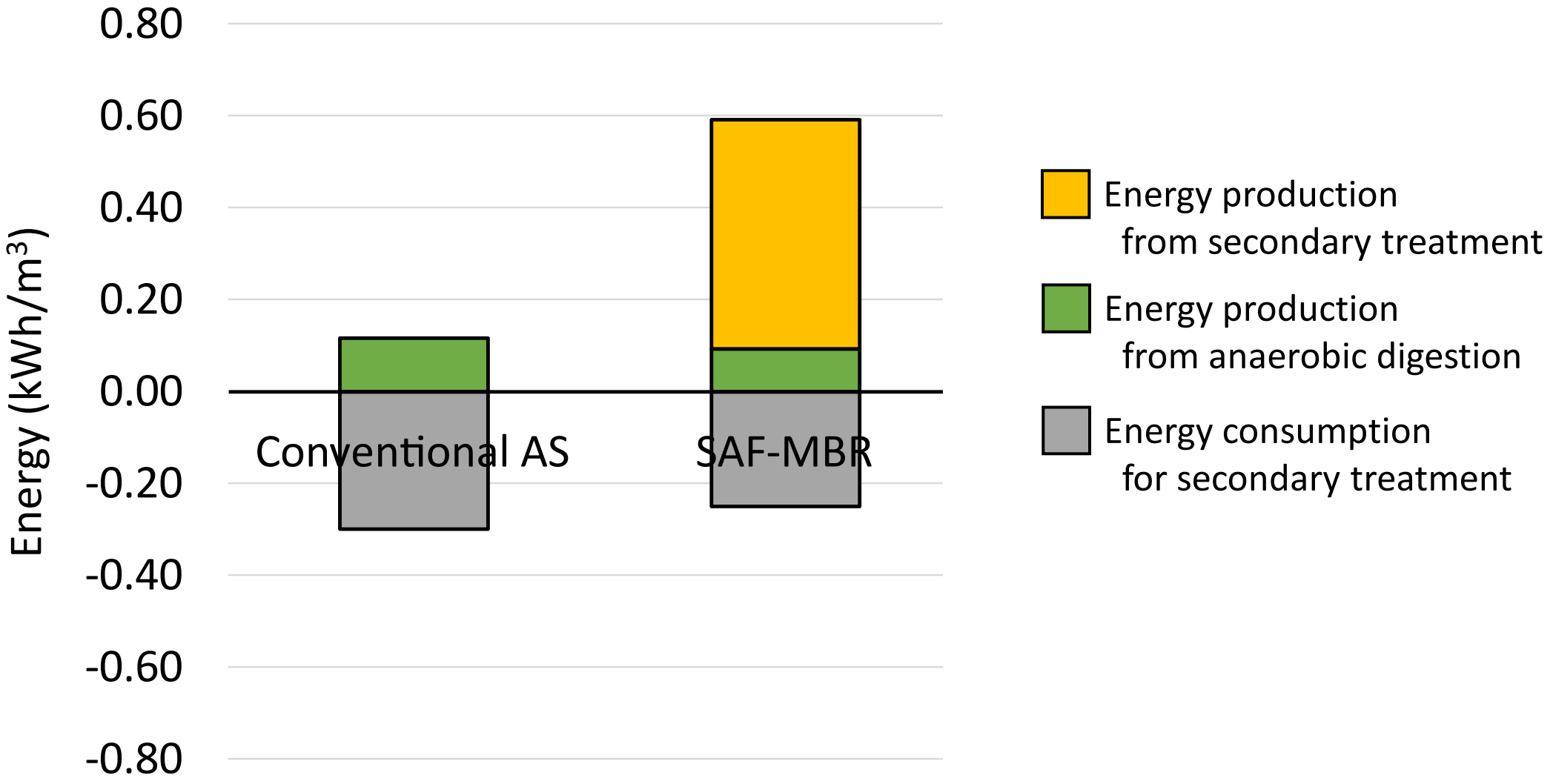
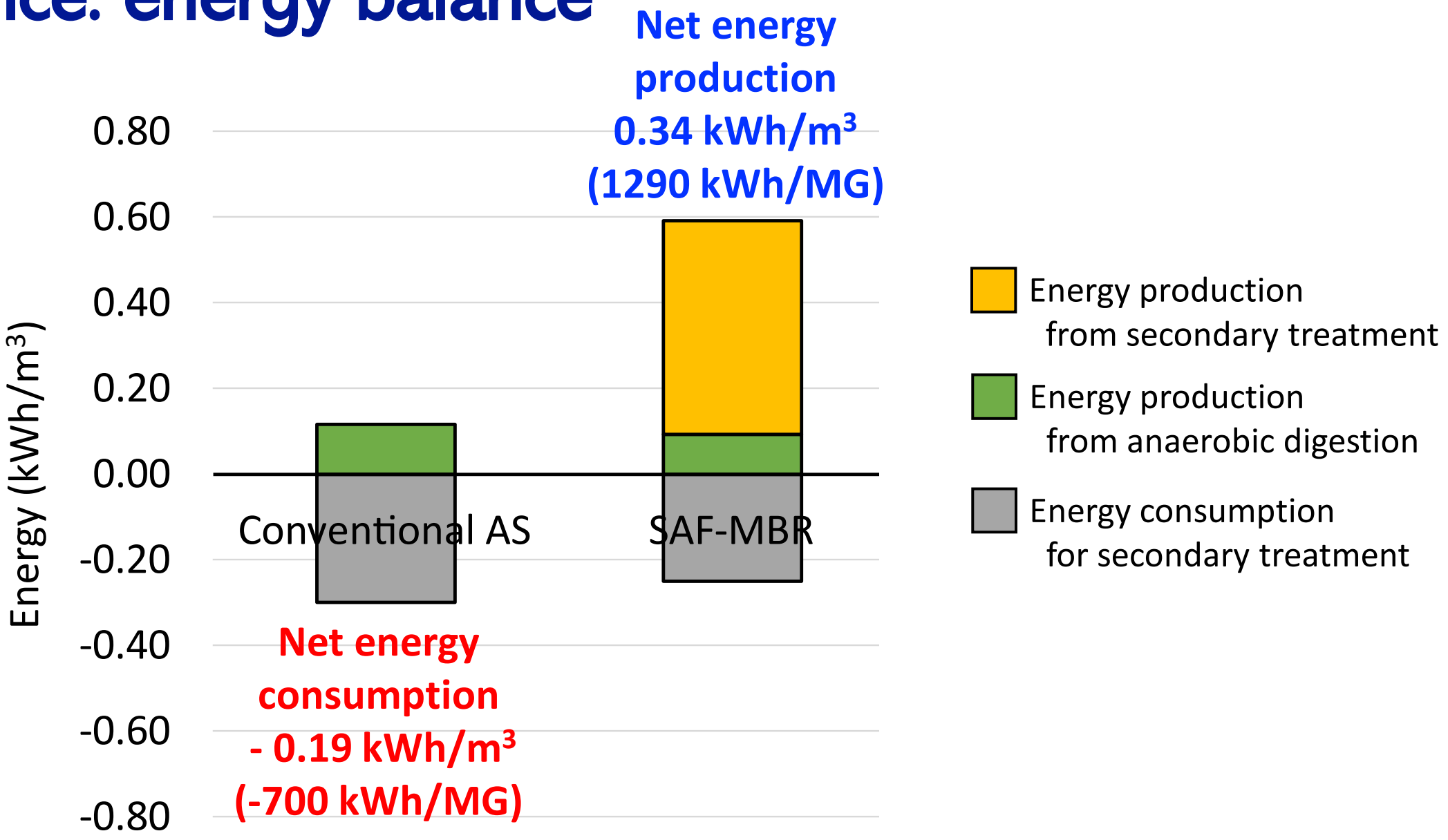


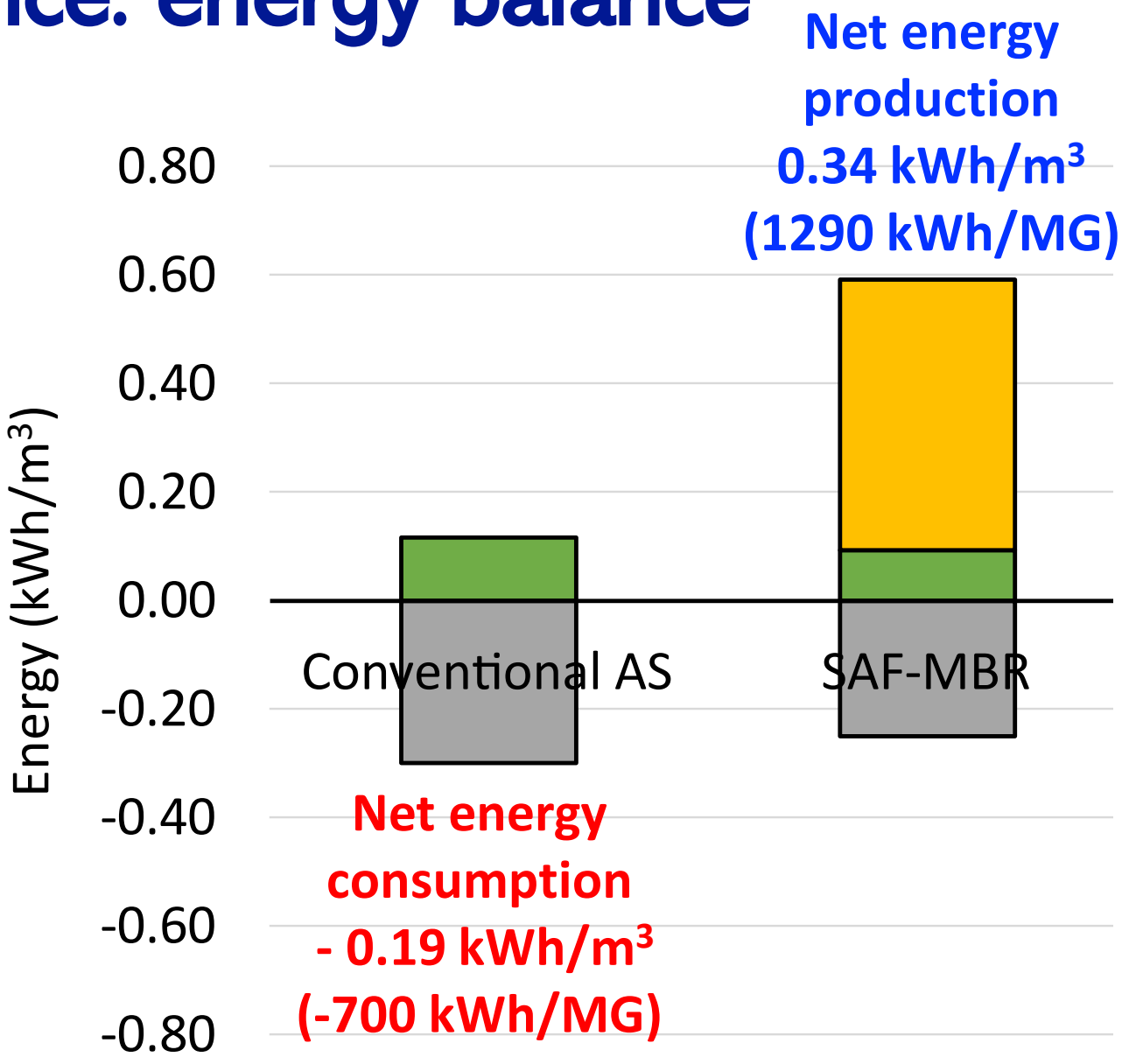
Performance: energy balance



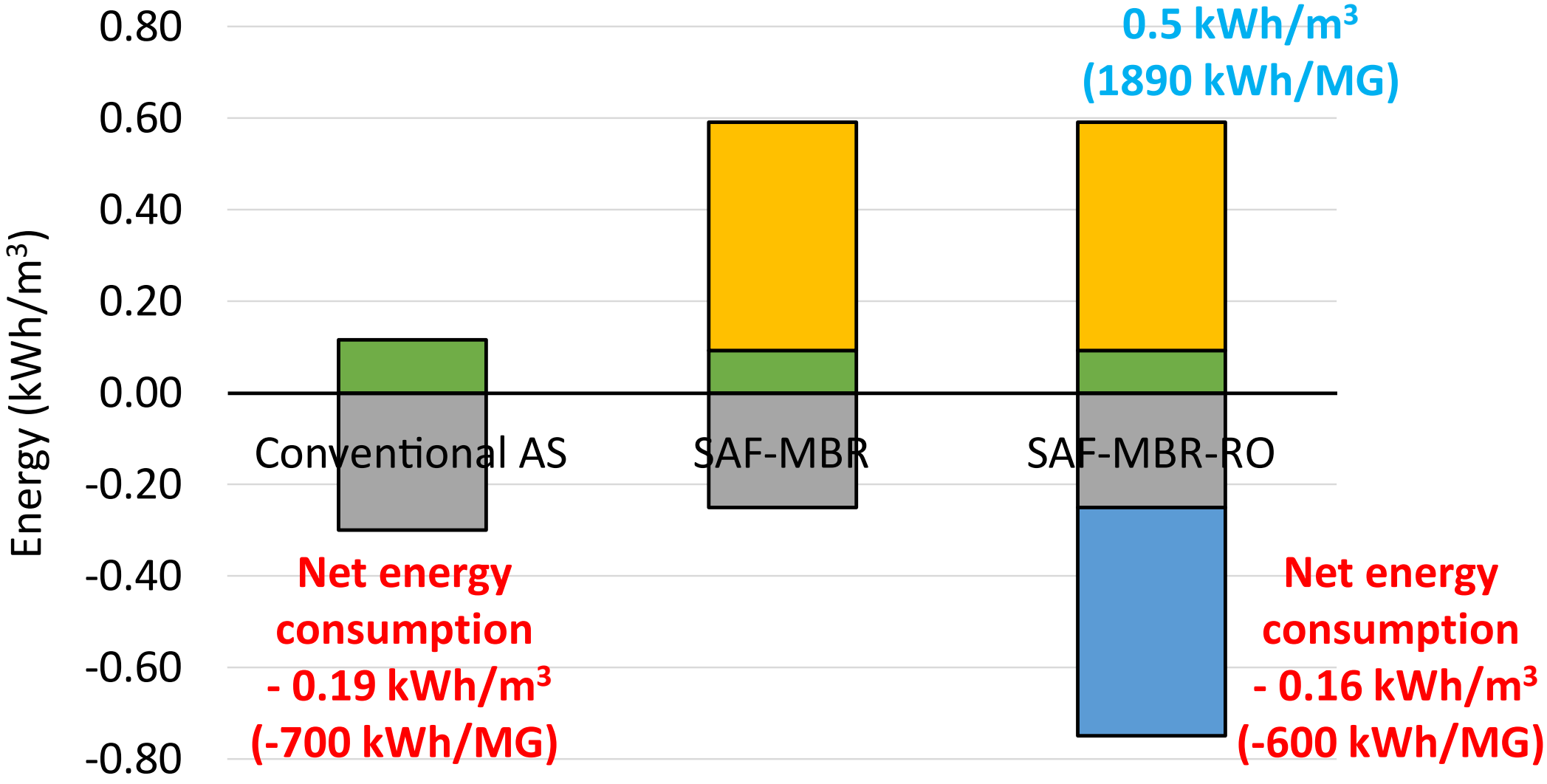
Performance: energy balance



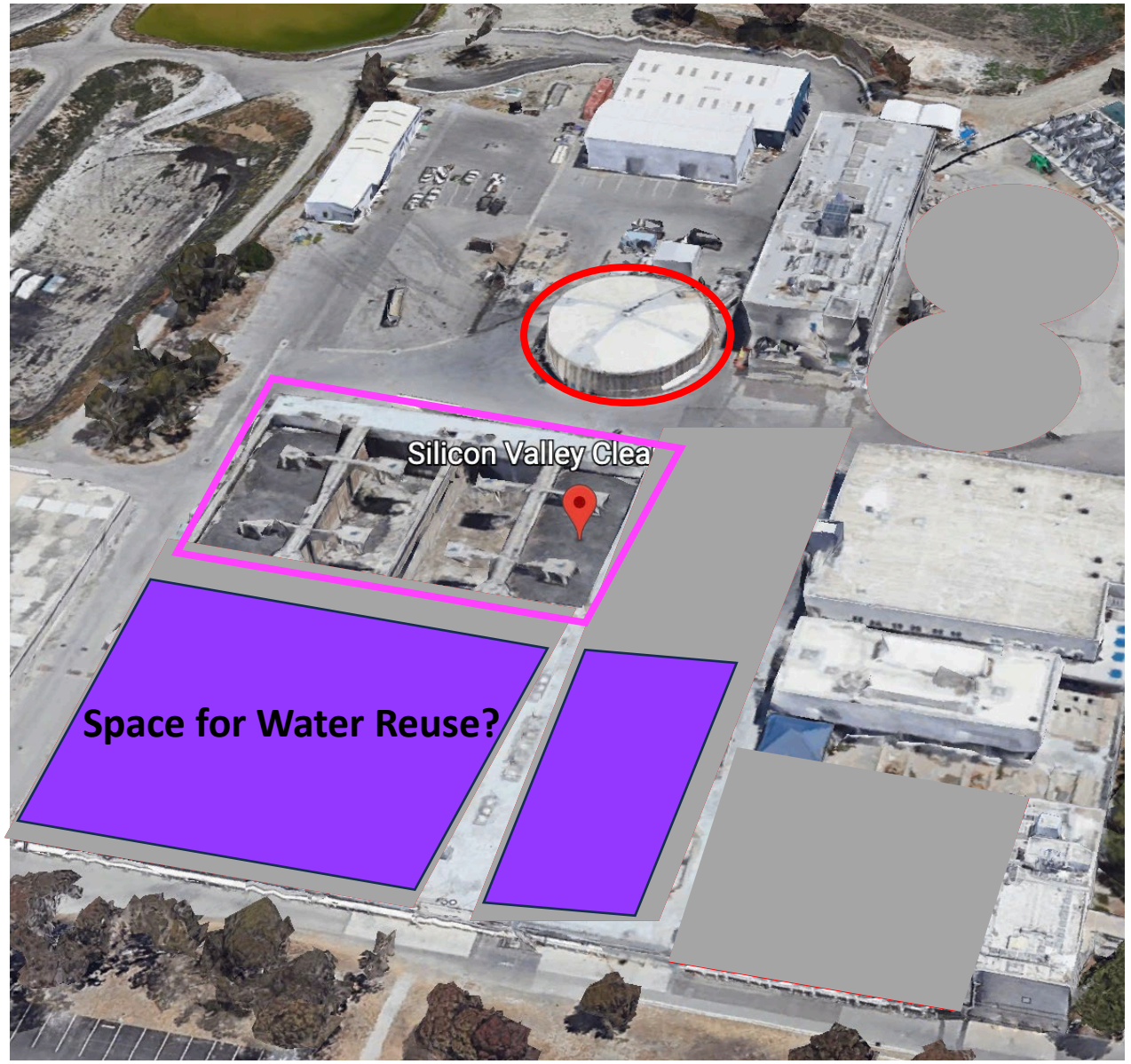
Performance: energy balance



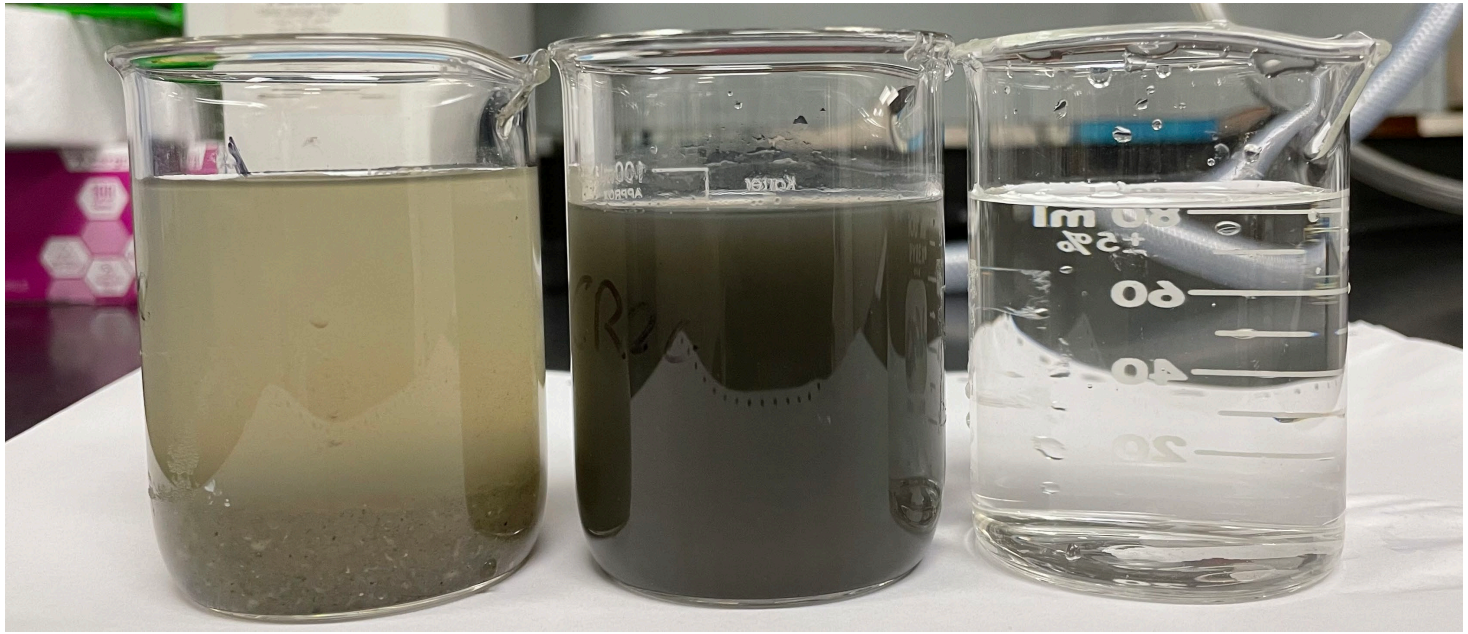
Performance: energy balance



Energy positive, Less footprint



Big punchlines



- Enables high-quality effluent
- First energy-positive secondary treatment system we know of
- 90% reduction of secondary solids
- Smaller footprint
- Enables energy-efficient water reuse

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Thank you

SVCW
Silicon Valley Clean Water
One Drop at a Time

Stanford | Codiga Resource Recovery Center

VEOLIA

BUREAU OF RECLAMATION